QA: QA

U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
OFFICE OF QUALITY ASSURANCE

REPORT FOR PERFORMANCE-BASED AUDIT OQAP-BSC-03-10 OF ANALYSIS MODEL REPORT PROCESSES AND PRODUCTS AT BECHTEL SAIC COMPANY, LLC LAS VEGAS, NEVADA

OCTOBER 21 - 31, 2003

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EXECUTIVE SUMMARY

Auditors representing the Office of Civilian Radioactive Waste Management (OCRWM) conducted a performance-based audit of Analysis Model Report (AMR) activities performed by Bechtel SAIC Company, LLC (BSC) and supporting national laboratories. The audit was conducted from October 21 to 31, 2003. The audit was performed to evaluate the implementation of the requirements contained in the DOE/RW-0333P, Revision 13, *Quality Assurance Requirements and Description* (QARD), focusing on AMR products and critical process steps that support the defensibility of inputs to the Yucca Mountain Project License Application (LA). In addition, the audit team evaluated the extent to which AMR implementing procedures addressed the requirements of the QARD.

The audit team concluded that, overall, the AMR procedures and processes were adequate (i.e., upper-tier requirements are addressed in the implementing procedures) and that the processes were effective in producing defensible AMRs to support the LA. However, the audit team determined that the procedures were not being satisfactorily implemented in the areas of documentation and traceability, model validation, and checking and review. Multiple occurrences of technical errors in AMRs, failure to meet requirements specified in Technical Work Plans (TWP), and model validation problems in two of the six AMRs evaluated by the audit team contributed to this conclusion. Conclusions regarding model validation are further supported by AMRs evaluated during Condition Report (CR) 99 (formerly Corrective Action Report (CAR) BSC-01-C-001) verification activities. These activities noted model validation problems in approximately 25 percent of the reviewed AMRs.

Table 1 summarizes audit team findings. There were no significant conditions adverse to quality (Level A CRs). Level B CRs are conditions adverse to quality, Level C CRs are minor conditions adverse to quality (which were corrected during the audit), and Level D CRs are opportunities for improvement.

Table 1. Audit Results Summary

Critical Process Step	Level B CRs	Level C CRs	Level D CRs
Planning and Development	0	0	1
Documentation and Traceability	3 (grouped)	2	4
Use of Data	3	0	0
Use of Software	2	1	1
Model Validation	2	1	1
Checking and Review	2 (grouped)	1	1
Procedure Adequacy	1	0	1
TOTALS	13	5	9

In the areas of documentation and traceability and checking and review, multiple instances of similar conditions were grouped under single CRs to facilitate development of appropriate corrective actions to preclude recurrence. Continued efforts to address the conditions in Table 1 will improve product defensibility.

The audit team also noted three noteworthy practices as described in Section 4.3.

1.0 PURPOSE AND SCOPE

A team of auditors representing the OCRWM and BSC QA conducted a performance-based audit from October 21 to 31, 2003, of AMR products and processes performed by BSC and supporting national laboratories. The audit team evaluated the effectiveness and implementation of applicable AMR procedures, processes, and products. In addition, the audit team evaluated the extent to which AMR implementing procedures addressed the requirements of the QARD. The audit team performed a vertical-slice evaluation of selected AMRs during the first week of the audit and a horizontal review of critical processes during the second week of the audit. The horizontal review drew audit samples from the total population of completed AMRs.

During the first week review, the audit team evaluated the following AMRs:

1. MDL-MGR-MD-000001, Revision 0, *Biosphere Model Report*
2. MDL-NBS-HS-000010, Draft 01D, *Site-Scale Saturated Zone Model*
3. MDL-NBS-HS-000004, Revision 2, *Seepage Calibration Model and Seepage Testing Data*
4. MDL-MGR-GS-000002, Draft 00F and 00G, *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada*
5. ANL-EBS-MD-000005, Revision 1, *Stress Corrosion Cracking of the Drip Shield, the Waste Package Outer Barrier, and the Stainless Steel Structural Material*
6. MDL-WIS-PA-000003, Revision 0, *Seismic Consequence Abstraction*

The Atmospheric Dispersal and Deposition AMR included two uncoupled models: 1) atmospheric dispersal (i.e., ASHPLUME) and 2) ash redistribution. No technical evaluation of the ash redistribution model was performed because the audit team did not include a technical specialist in that area. The ASHPLUME portion of the model report was, however, fully evaluated.

Two AMRs, *Site-Scale Saturated Zone Model* and *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada*, had not been issued at the time of the audit. In these cases, audit activities considered objective evidence obtained through the checking process only.

During the second week review, the audit team evaluated the following critical process steps:

1. Planning and development
2. Documentation and traceability
3. Use of data
4. Use of software
5. Model validation
6. Checking and review
7. Procedure adequacy

These products and processes formed the basis for the checklist questions used by the audit team during the audit. In addition, the audit team evaluated previous condition reports related to AMRs and AMR processes to determine the effectiveness of the corrective actions. The primary emphasis was the evaluation of CR 99 (previously identified as CAR BSC-01-C-001) corrective actions.

2.0 AUDIT TEAM MEMBERS AND OBSERVERS

2.1 AUDIT TEAM MEMBERS

Bruce D. Foster, Navarro Quality Services (NQS)/Audit Team Leader
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2.2 AUDIT OBSERVERS

Robert D. Brient, Southwest Research Institute/Center for Nuclear Waste Regulatory Analysis (SRIC), Acting Team Leader
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Gary Walter, SRIC
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Yi-Ming Pan, SRIC
Thomas C. Trbovich
William J. Boyle, DOE/Office of Repository Development

3.0 AUDIT MEETINGS AND PERSONNEL CONTACTED

A pre-audit meeting was held on October 21, 2003, in Las Vegas, Nevada (and at remote locations via telephone). Daily team meetings were conducted to discuss the progress and status of the audit, including potential conditions adverse to quality. Daily management meetings were held to keep BSC and laboratory management informed of audit issues and status. The audit was concluded with a post-audit meeting on October 31, 2003, in Las Vegas, Nevada.

Personnel contacted during the audit, including those who attended the pre-audit and post-audit meetings are listed in Attachment 1, "Personnel Contacted During the Audit."

4.0 AUDIT DETAILS

The following detailed audit results are presented in the areas of adequacy, implementation, and effectiveness. These terms are defined as follows:

- Adequacy – The extent to which upper-tier requirements are incorporated into implementing documents (i.e., procedures).

- Implementation – The extent to which processes are performed in accordance with applicable procedures.

- Effectiveness – The extent to which processes or products satisfy stated objectives or support the desired end state.

The measures used to determine adequacy, implementation, and effectiveness are satisfactory or unsatisfactory. For the purpose of this audit report, these terms are defined as follows:

- Unsatisfactory – The identification of issues significantly jeopardizes the ability of a process or product to meet established expectations.

- Satisfactory – The preponderance of available information supports affirmation that a given process or product meets established expectations. For the purpose of this audit report, satisfactory performance is further subdivided into the following color ratings:

  Blue: Exceptional - performance that can be considered best in class.

  Green: Performance meets expectations yielding satisfactory results.

  Yellow – Minor Issues - Performance meets requirements with only minor issues identified. These issues do not significantly compromise the quality of the product or process.

These color ratings are intended to serve as indicators to focus management attention on areas where improvements are desired. Unsatisfactory determinations are given a red color rating.

4.1 OVERALL EVALUATION OF PROGRAM ADEQUACY, IMPLEMENTATION, AND EFFECTIVENESS

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	Unsatisfactory- Red	Satisfactory - Yellow

The audit team concluded that, overall, the AMR procedures and processes were adequate (i.e., upper-tier requirements were addressed in the implementing procedures) and that the processes were effective in producing defensible AMRs supporting the LA, provided procedural requirements were met. However, the audit team determined that the procedures were not being

satisfactorily implemented in the areas of documentation and traceability, model validation, and checking and review. Multiple occurrences of technical errors identified in AMRs, failure to meet requirements specified in TWPs, and model validation problems identified in two of the six evaluated AMRs (ANL-EBS-MD-000005 and MDL-MGR-GS-000002) contributed to this conclusion. Conclusions regarding model validation are further supported by AMRs evaluated during CR 99 (formerly CAR BSC-01-C-001) verification activities. The CR 99 verification team noted model validation problems with approximately 25 percent of the reviewed AMRs.

The overall audit conclusion is based on evaluation of the critical process steps and AMR products identified in Section 1. Summary results of critical process step evaluations and AMR products are presented in Section 4.2. The CRs generated as the result of these evaluations and noteworthy practices are discussed in Section 4.3.

4.2 AUDIT RESULTS SUMMARIES

Attachment 2, "Summary Table of Audit Results," shows audit results for the sub-processes and products evaluated by the audit team. Details of audit activities, including a description of the objective evidence reviewed, are documented in the audit checklist located in the Records Processing Center (RPC). A listing of specific documentation reviewed is identified in Attachment 3, "Documentation Evaluated during the Audit."

4.2.1 Results by Critical Process Step

4.2.1.1 *Planning and Development*

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	Satisfactory - Green	Satisfactory - Green

The planning and development process involved preparation of TWPs to govern AMR development and compliance with applicable procedures to ensure that AMR products meet the requirements of the QARD. Audit activities included the review for adequacy of the governing planning procedure, AP-2.27Q, Revision 1, ICN 1, *Planning for Science Activities*, and selected TWPs and associated AMRs developed in accordance with the TWPs. Incorporation of applicable features, events, and processes (FEP) and Key Technical Issues (KTI) into the AMR planning process was also evaluated. The TWPs governing seven AMRs were evaluated (one during week one and six during week two). Overall, the AMR planning and development process was determined to be adequate, satisfactorily implemented, and effective. One opportunity for improvement (Level D CR 1157) was issued in this area.

4.2.1.2 *Documentation and Traceability*

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	Unsatisfactory - Red	Satisfactory - Yellow

The audit team examined a total of 11 AMRs (6 during week one and 5 during week two), their associated development and review records, and a sample of technical references and data inputs to determine the thoroughness and transparency of documentation and traceability of

information. In addition, the audit team examined AMRs for implementation of the technical error reporting process and reviewed previously issued conditions adverse to quality to determine effectiveness of any related corrective actions. Audit activities consisted of interviews and reviews of documentation.

Overall, AMR documentation and traceability was determined to be adequate and effective. However, implementation problems with traceability and transparency were identified resulting in a conclusion of unsatisfactory implementation of procedural requirements in this area. The treatment of assumptions in AMRs does not appear to be consistent or well understood. Section 5 of the AMRs addresses assumptions. In some cases, an inordinate number of assumptions are listed in Section 5, while other AMRs contain few or no assumptions in Section 5, and the assumptions are distributed throughout Sections 6 and 7 of the report.

Three Level B CRs (1150, 1152, and 1172), two Level C CRs (1142 and 1160), and four Level D CRs (1078, 1140, 1153 and 1155) were issued in this area. The two Level C CRs were corrected during the audit.

4.2.1.3 *Use of Data*

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	Satisfactory - Yellow	Satisfactory - Green

A total of 10 AMRs (6 during the first week and 4 during the second week) were evaluated with respect to data use and control. Audit activities consisted of interviews and review of AMRs, Document Input Reference System (DIRS) entries, record road maps, and Technical Data Management System (TDMS) entries. In general, the reviewed AMRs were well prepared, provided excellent explanations for data selection and use, and met procedural requirements related to data. An isolated occurrence of data used as technical information and technical information used as a qualification status was identified.

In addition, one document (ANL-EBS-GE-000004, Revision 00, ICN 01, *Effects of Fault Displacement on Emplacement Drifts*, dated April 25, 2000, with Errata 31673 dated March 04, 2002) was determined to be unsatisfactory with respect to data control. This document is an analysis prepared for the site recommendation that is intended to support the LA without revision. This document did not meet the current requirements for use of data nor those in effect at the time of the preparation of the document. The satisfactory classifications are based on the presumption that ANL-EBS-GE-000004 will not be taken forward to licensing in its present condition, but will be modified to be in compliance with the applicable procedures. Overall, use of data was determined to be adequate, implemented, and effective. Three Level B CRs (1162, 1163, and 1168) were identified in this area.

4.2.1.4 *Use of Software*

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	Satisfactory - Green	Satisfactory - Green

The methodology for software selection and control when used in AMRs was evaluated. A total of 11 AMRs were reviewed (6 AMRs the first week and 5 AMRs the second week). Software records packages were reviewed and found to be complete for the requirements of AP-SI.1Q, Revision 5, ICN 2, *Software Management*. The software programs used by these AMRs were qualified prior to use and referenced in the applicable section of the AMRs.

The audit team evaluated off-the-shelf general-purpose software, as well as software developed specifically for the project. The software packages examined by the audit team had Validation Test Plans and Validation Test Reports (VTR) describing which modules had been validated and which modules were not required to be validated. In all cases, the software was determined to be appropriate for the intended use. Justification was provided for the selection of the particular software package. Software issues were identified, however, with respect to identification of software modules used in AMRs, documentation of software validation test results, and software user training.

Through direct examination of the AMRs, the review of VTRs, and discussions with the originators, all indications were that the software produced accurate results within some range of uncertainty, rather than systematically conservative (or nonconservative) results. Input data were described and properly documented in the data tracking system; outputs were listed, software versions and identification numbers were provided; and the selection of algorithms where choices were available were described and the rationale for selection was presented. Overall, software use was determined to be adequate, implemented, and effective. Two Level B CRs (1132 and 1164), one Level C CR (1129), and one Level D CR (1130) were issued. The Level C CR was corrected during the audit.

4.2.1.5 *Model Validation*

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	Unsatisfactory - Red	Satisfactory - Yellow

The audit team evaluated the activities associated with model validation to determine if the validation activities met the requirements of the QARD, AP-SIII.10Q, Revision 2, *Models,* the TWP, and the guidelines in the *Scientific Processes Guidelines Manual.* In addition, the audit team reviewed the preliminary conclusions of the CR 99 (formally CAR BSC-01-C-001) verification team. A total of 20 AMRs were reviewed. Two of the six AMRs reviewed during the first week of the audit were determined to be unsatisfactory with respect to model validation. In addition, the CR 99 validation team identified five unsatisfactory validation categories related to three additional AMRs. The categories include the criteria for model accuracy, the uncertainty discussions in the AMR, the adequacy of the confidence builders, the adequacy of the validation documentation, and the model's level of confidence. The transparency and consistency of several of the AMRs reviewed by the audit team require improvement to more clearly demonstrate how these various attributes were covered.

The specificity in several of the TWPs was lacking with respect to the acceptance criteria for the model (level of confidence, accuracy of the model, treatment of uncertainties, etc). In other cases, the AMR did not clearly address the requirements identified in the TWP.

Overall, the audit team concluded that this area, as described in the modeling procedures, was satisfactory from adequacy and effectiveness standpoints, but was unsatisfactory relative to consistent implementation of the procedural requirements. The model validation process was effective when procedural requirements were met. Two Level B CRs (1169 and 1177), one Level C CR (1178) and one Level D CR (1159) were issued. The Level C CR was corrected during the audit.

4.2.1.6 *Checking and Review*

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	Unsatisfactory - Red	Satisfactory - Yellow

The audit team evaluated the checking and review process by conducting interviews and reviewing AMRs and comment response documentation. A total of 15 AMRs (6 during the first week and 9 during the second week) and the associated review documentation were examined.

A number of technical errors identified concerns with report correctness and with checking adequacy. These errors were noted in 5 of the 15 AMRs reviewed, but were determined to have no significant impact on the completed AMRs. The five AMRs identified by the audit team that exhibited errors were:

- MDL-MGR-GS-000002, Drafts 00F and 00G, *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada*
- MDL-NBS-HS-000004, Revision 02, *Seepage Calibration Model and Seepage Testing Data*
- MDL-NBS-GS-000002, Revision 1, *Geologic Framework Model*
- MDL-NBS-HS-000010, Draft 01D, *Site-Scale Saturated Zone Model*
- ANL-EBS-MD-000005, Revision 01, *Stress Corrosion Cracking of the Drip Shield, the Waste Package Outer Barrier, and the Stainless Steel Structural Material*

In addition, the audit team determined that TWP requirements were not consistently evaluated during the checking and review process. One instance was identified where the author and checkers were unaware of the TWP requirements. The team determined that checking and review requirements were not always being adequately implemented.

Overall, the process was found to adequately address program requirements, and was determined to be effective. However, the area of procedure implementation was concluded to be unsatisfactory. Two Level B CRs (1138 and 1173), one Level C CR (1142), and one Level D CR (1141) were issued. The Level C CR was corrected during the audit.

4.2.1.7 *Procedure Adequacy*

Program Adequacy	Implementation	Effectiveness
Satisfactory - Green	N/A	N/A

The flow of requirements into procedures that implement AMR processes was evaluated. This evaluation included a review of procedures and a comparison of QARD compliance matrices against those procedures. The evaluation also included a roll-up of the adequacy determinations from the critical process steps addressed in Sections 4.2.1.1 through 4.2.1.6 of this audit report. In addition, an independent gap analysis was performed against procedure AP-SIII.10Q relative to the QARD requirements. The results of this gap analysis are documented with the audit checklist. Interviews were conducted to discuss apparent discrepancies.

Overall, the flow of QA requirements into implementing procedures was determined to be satisfactory. However, an issue was identified regarding the failure of procedures to address the use of informal reviews. The current practice of performing informal reviews during the various phases of quality-affecting activities associated with document development and review was not addressed by the procedures. One Level B CR (1149) and one Level D CR (1158) were issued.

4.2.2 Results by AMR

4.2.2.1 *MDL-MGR-MD-000001, Revision 0, Biosphere Model Report (B0090)*

Program Adequacy	Implementation	Product Effectiveness
N/A	Satisfactory - Green	Satisfactory - Green

The audit team performed a vertical-slice evaluation of the MDL-MGR-MD-000001, *Biosphere Model Report*. This evaluation consisted of interviews with key personnel, reviews of documentation, and observation of the model implementation using GoldSim software. Data flow from the input AMRs through the *Biosphere Model Report* and into the biosphere dose conversion factor analysis was also evaluated.

Audit results indicate that the input parameter data from AMR feeds, the conceptual model, and mathematical models were appropriately implemented in the biosphere model. This model was appropriately validated, and the results were adequately described. There was no abstraction of model results. All results will be carried forward into Total System Performance Assessment (TSPA). Completion of a sensitivity analysis will complete the process. Two noteworthy practices related to transparency of the biosphere model implementation in GoldSim and the sensitivity analysis process were identified (see Section 4.3). Overall, this AMR was determined to satisfactorily implement procedural requirements, and the biosphere model development, validation, and result production processes were determined to be effective. No determination of adequacy was made because requirements flow down into procedures was not assessed in this area. One Level D CR (1140) was issued.

4.2.2.2 *MDL-NBS-HS-000010, Draft 01D, Site-Scale Saturated Zone Model (S0025)*

Program Adequacy	Implementation	Product Effectiveness
N/A	Satisfactory - Yellow	Satisfactory - Green

The audit team evaluated the *Site-Scale Saturated Zone Model* AMR and the associated TWP (*Technical Work Plan for Saturated Zone Flow and Transport Modeling and Testing*). This AMR was still in draft form, but it had completed the checking process and was, therefore, assessed against all required activities through checking. The TWP was evaluated to determine if it was prepared in accordance with the requirements of AP-2.27Q and if it clearly identified the technical and administrative criteria to be met for the *Site-Scale Saturated Zone Model* AMR.

In addition, the audit team evaluated the AMR to verify that 1) it had been planned and prepared in accordance with AP-SIII.10Q, 2) the AMR met the criteria identified in the TWP, 3) the intended purpose was met, 4) the required level of confidence was addressed, and 5) all QARD requirements were satisfied. The evaluation was performed through a review and analysis of the AMR, reviews of other documentation, and discussions with the AMR developer and the Chief Science Office reviewers.

The audit team identified issues in the areas of technical assumptions, AMR validation, the use of data as technical information, data traceability, software documentation, and editorial and reference errors. A recommendation was provided to enhance the defensibility of AMR MDL-NBS-HS-000010 by incorporating the microsphere breakthrough data from the C-wells. Overall, the audit team concluded that the process employed in this AMR was in accordance with the TWP, was well implemented, and was effective. Though several conditions related to implementation were identified in this area, the audit team determined that the conditions did not compromise the ability of the product to meet its stated objective. Five Level B CRs (1162, 1163, 1164, 1138, 1172), one Level C CR (1178), and one Level D CR (1159) encompass the conditions identified through evaluation of this AMR. The Level C CR was corrected during the audit.

4.2.2.3 *MDL-NBS-HS-000004, Revision 02, Seepage Calibration Model and Seepage Testing Data (U0080)*

Program Adequacy	Implementation	Product Effectiveness
N/A	Satisfactory - Green	Satisfactory - Green

The audit team reviewed AMR MDL-NBS-HS-000004 to determine if the AMR achieved its stated objectives. This review included a compliance component and a technical performance component. Audit activities consisted of interviews with responsible personnel; review of supporting records and data; and visual examination of computer runs to assess traceability, accuracy, and completeness. In addition, independent calculations based on the applicable data were performed to assess possible issues surrounding calibration and validation.

To confirm technical performance, the audit team examined the raw data and the critical calculations based on these raw data that led to the calibration results given in the AMR. The audit team reproduced key calculations that formed the basis for the critical calibration parameter

of interest and the most significant output parameter from the model. Independent checks to determine if the calibration results could have been artifacts of test geometry, boundary conditions, or other factors not related to the effective properties of the rock alone were performed. Results from these checks were discussed with the AMR author and others knowledgeable in the technical scope of the AMR. During this part of the audit, a data transcription error and a text error with no material consequence to the technical calculations or output parameters were identified.

Overall, the audit team concluded that this AMR was implemented in accordance with procedural and TWP requirements and was effective. Two Level B CRs (1138 and 1172), one Level C CR (1079), and one Level D CR (1078) address the conditions identified through evaluation of this AMR. The Level C CR was corrected during the audit.

4.2.2.4 *MDL-MGR-GS-000002, Drafts 00F and 00G, Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada (T0125)*

Program Adequacy	Implementation	Product Effectiveness
N/A	Satisfactory - Yellow	Satisfactory - Green

The audit team reviewed AMR MDL-MGR-GS-000002 to evaluate procedural implementation and product effectiveness. This review was based on interviews with personnel and a review of the documentation. The audited versions of this AMR, Drafts 00F and 00G, consisted of a back-check version and a back-back-check version, respectively. Neither version had gone through AP-2.14Q review at the time of the audit. Therefore, the audit team examined only those activities performed through the checking process for this AMR.

Two conceptual models are described in the AMR: 1) the ASHPLUME tephra dispersal and deposition mathematical model, and 2) the ash redistribution conceptual model. The ash redistribution conceptual model was a relatively recent addition to the report, and the audit team did not posses the technical expertise to evaluate the adequacy of that model. Therefore, the focus of the technical evaluation of this AMR was the dispersal and deposition model. Adequacy conclusions given below apply only to that model.

The dispersal and deposition model (i.e., ASHPLUME model) has undergone a number of validation activities, including a comparison with three analog studies, sensitivity analyses for parameter distributions, evaluation against alternative models, and an independent technical review. These activities are adequately described in Chapter 7 of the model report. The analog and parameter sensitivity studies were used to refine parameter inputs that directly support the TSPA GoldSim model. ASHPLUME model limitations and parameter uncertainties are also addressed. Model limitations are handled by assumptions that, in most cases, result in predicted impacts that are conservative. Parameter uncertainty is handled by parameter distributions covering the full range of parameter values.

In relation to the ash redistribution conceptual model, the audit team identified a failure to validate the model by independent technical review, as required by the governing TWP (TWP-WIS-MD-000007). In addition, the failure to meet this requirement had not been identified by anyone in the model documentation development and review chain.

From a documentation and traceability perspective, there were problems related to editorial and typographical errors, unsupported statements of fact, and information that could not be located in the cited reference documents. Overall, the audit team determined that the issues identified were minor problems and concluded that the ASHPLUME dispersal and deposition model was acceptable with the correction of the adverse conditions. The ASHPLUME model described in the AMR was determined to be effective for its intended use. Two Level B CRs (1138 and 1173) and one Level D CR (1155) address the conditions identified through evaluation of this AMR.

4.2.2.5 *ANL-EBS-MD-000005, Revision 01, Stress Corrosion Cracking of the Drip Shield, the Waste Package Outer Barrier, and the Stainless Steel Structural Material (W0095)*

Program Adequacy	Implementation	Product Effectiveness
N/A	Unsatisfactory - Red	Unsatisfactory - Red

The audit team reviewed ANL-EBS-MD-000005 to evaluate procedure implementation and effectiveness. Audit activities consisted of interviews and a review of the AMR documentation, DIRS entries, and data. This AMR had been audited previously as part of audit OQAP-BSC-03-14, a performance-based audit of technical product inputs, which was conducted from September 8 to 19, 2003. During that audit, five CRs were cited with references to this model report (CRs 773, 785, 787, 789, and 792). The conditions cited in these CRs are considered previously identified and are not repeated in this audit report, but are indicative of the overall product quality.

Except as noted in the previous audit, inputs for this AMR were appropriately selected, described, justified, and used. The qualification and verification status of the data and information was satisfactory. Data values were consistent with the values in the original sources. References in the document were readily available and supported the statements in the document.

The audit team identified issues with this AMR in relation to compliance with the relevant technical work plan, technical reference errors, unsupported statements of fact, and data validation. The subject of stress corrosion cracking of Alloy C-22 in particular is very complex and data for Alloy C-22 are extremely sparse. Laboratory testing has yet to implement a test scenario that will cause the C-22 material to initiate a stress corrosion crack under conditions that can be reasonably expected at Yucca Mountain. The initiation of such a crack is required for a threshold stress intensity factor (K_{ISCC}) to be experimentally determined. Absent this experimentally determined value, calculated values for K_{ISCC} were used. Many of the technical issues relate to these calculated values and the methodology to derive the K_{ISCC} value. The following issues were identified:

- The AMR did not address the identified FEPs in the governing TWP, and it did not address applicable Yucca Mountain Review Plan criteria as required by the TWP. In addition, the validation method used for this model was not consistent with the validation methods specified in the TWP.

- Experimental results derived from samples were used to determine parameters associated specifically with Alloy C-22. According to the model report, these same samples were then used to validate the model. This practice is not permitted by the QARD, (Section III.2.6.F.2).

- The conceptual model for stress corrosion cracking of the waste package outer barrier was derived from an industry model used for stainless steel and Alloy-600, a nickel-base alloy. While the industry model (slip dissolution/film rupture model) used may be acceptable for use with Alloy C-22, the AMR does not make a strong technical case for the applicability of the model to Alloy C-22 in the postulated Yucca Mountain environment.

Overall, the audit team determined that this AMR was not satisfactorily implemented in accordance with required procedures, and that the AMR was not effective in meeting its intended purpose. Four Level B CRs (1138, 1150, 1173, and 1177) addressed the conditions identified during the evaluation of this AMR.

4.2.2.6 *MDL-WIS-PA-000003, Revision 0, Seismic Consequence Abstraction (E0145)*

Program Adequacy	Implementation	Product Effectiveness
N/A	Satisfactory - Green	Satisfactory - Blue

The audit team evaluated implementation and effectiveness of MDL-WIS-PA-000003, *Seismic Consequence Abstraction*. Audit activities consisted of interviews and a review of the associated documentation and data. In general, the AMR was a well-written report. It followed the outlines for model and scientific analysis reports contained in AP-SIII.10Q, Revision 1, and AP-SIII.9Q, Revision 0. The AMR clearly stated the assumptions used for model development, and it clearly explained and articulated the uncertainties associated with the data inputs and the model outputs. The AMR implemented the most recent and applicable TWP guidance contained in TWP-MGR-MD-000015, Revision 4, ICN 01.

The AMR was effective in abstracting the seismic scenario class damage estimates on the various engineered barrier system (EBS) components and in supplying the needed data and information inputs to TSPA.

Overall, the audit team determined that this AMR was satisfactorily implemented in accordance with procedural requirements and was effective in accomplishing the stated objective. Of particular note was the interface established between the AMR team and the TSPA team. This interface was instrumental in ensuring appropriate treatment of the topical matter required to support the LA. One Level C CR (1160) and one Level D CR (1153) were issued. The Level C CR was corrected during the audit.

4.3 SUMMARY OF CONDITION REPORTS AND NOTEWORTHY PRACTICES

The audit team identified three noteworthy practices, thirteen Level B CRs, five Level C CRs, and nine Level D CRs. Noteworthy practices are described in Section 4.3.1. Level B CRs are described in Section 4.3.2, Level C CRs are described in Section 4.3.3, and Level D CRs are described in Section 4.3.4. Section 4.3.5 describes the evaluation of previous conditions for

recurrence. In addition, this section examines the effectiveness of CR 99 (CAR BSC-01-C-001) corrective action in light of the conditions identified in this report.

4.3.1 Noteworthy Practices

The following noteworthy practices were identified during the audit:

- The transparency of the Biosphere Model implementation in GoldSim was exceptional. This level of transparency provided a very clear depiction of biosphere interactions.

- The Biosphere Model developers are preparing a sensitivity analysis to further evaluate the dependencies and sensitivities of the model. This activity continues despite the disbandment of the Biosphere Model Development Group. Sensitivity analysis data have proven valuable in explaining areas of technical concern. The sensitivity analysis effort should be continued.

- An effective interface was established between the Seismic Consequence *Abstraction* AMR team and the TSPA modeling team. The AMR author and the TSPA modeler worked closely to ensure that the format and nature of AMR output met expectations for the TSPA input. The modeling team familiarity with GoldSim facilitated this seamless interaction.

4.3.2 Conditions Adverse to Quality (Level B)

A total of 13 Level B CRs were identified. These CRs are described below.

4.3.2.1 *CR 1132*

No documentation was available identifying which modules from commercially developed software were used in two AMRs.

Requirement

AP-SI.1Q, Revision 5, ICN 2, Section 5.1.2.2, requires in part that software be controlled and documented to demonstrate the use of qualified software within the range of validation in which the software was originally qualified.

Condition

There was no documentation available that identified which validated modules of commercially derived software, EARTHVISION V 5.1 and ANSYS V 5.6.2, were used in AMRs MDL-NBS-GS-000002, Revision 01, *Geologic Framework Model* and ANL-EBS-MD-00030, Revision 03, ICN 01, *Ventilation Model and Analysis Report*. Though the audit team was able to confirm through interviews that appropriate qualified software modules were used, this fact was not documented in the record.

4.3.2.2 *CR 1138*

An adverse trend in documentation errors was identified in AMRs. These errors resulted in problems with transparency, accuracy, completeness, and correctness.

Requirements

QARD, SIII.2Q, Revision 1, ICN 1, *Qualification of Unqualified Data*, Section B requires that documentation of models shall be transparent. The QARD defines transparent as: "A document is transparent if it is sufficiently detailed as to purpose, method, assumptions, inputs, conclusions, references and units such that a person technically qualified in the subject can understand the document and ensure its adequacy without recourse to the originator."

AP-SIII.10Q, Revision 2, ICN 0, Section 5.4.3, requires in part that the checker:

a) Check the model documentation ensuring that

1) The content and output of the model are technically adequate, complete and correct.

3) Appropriate technical product inputs were selected, correctly identified in the model documentation and on the DIRS report, cited and incorporated in the modeling activity in accordance with AP-3.15Q, Revision 4, ICN 2, *Managing Technical Product Inputs*

10) The referencing is thorough, accurate, and complete.

Condition 1

Errors were found during review of MDL-MGR-GS-000002, *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada*. This AMR had been through the checker and quality engineering reviews at least twice and was being readied for AP-2.14Q review. A cursory read of Revision 00F (labeled BACKCHECK COPY) identified a number of typographical errors, one of which affected the technical accuracy of the statement made. In Section 6.6.2 on page 64 of the report, the reasonably maximally exposed individual (RMEI) location is identified as 20 kilometers from the proposed repository. The correct distance is 18 kilometers. This error was present in Revision 00F and Revision 00G (also labeled BACKCHECK COPY and the latest version available at the time of the audit) of the model report.

In addition, examples of editorial and typographical errors were identified in Revision 00G.

Condition 2

AMR MDL-MGR-GS-000002, Revision 00F, had completed the checker and quality engineering representative (QER) reviews at least twice, and was being readied for AP-2.14Q review (Revision 00G). At that advanced stage of preparation, the document contained unsupported statements of fact and cited information that could not be confirmed.

Examples of unsupported statements of fact included the following:

- Page 27, rationale paragraph under Section 5.1.1.
- Page 41, entire paragraph starting at bottom of page.
- Page 42, first full paragraph starting with "The plume rises . . .

- Page 61, first full paragraph, 2nd sentence: No support for statement "… last eruption at Sunset Crater occurred only about 1 kya …"
- Page 64, Section 6.6.2, first paragraph.

Examples of cited information that could not be confirmed in identified references included the following:

- Page 54, Jarzemba reference to information on page 4-1.
- Page 61, Heizler citation: Information on cited page 767 could not be located.
- Page 69, 3rd paragraph, last sentence: "5 waste packages" in the referenced document could not be located.
- Page 83, Figure 7.1: Figure in the document given as the source could not be located.

Condition 3

The following errors were found during the review of AMR ANL-EBS-MD-000005, Revision 1, *Stress Corrosion Cracking of the Drip Shield, the Waste Package Outer Barrier, and the Stainless Steel Structural Material*:

- NRC 2002 [158449] is listed as a reference in Section 1.0. DIRS lists it as NRC 2003 [254002]. No NRC 2002 exists in the DIRS.
- DIRS reference 19 is identified as CRWMS M&O 1999, *Classification of the MGR Ex-Container System,* ANL-XCS-SE-000001 REV 00 [106190]. The reference in Section 2.0 of the AMR identifies it as CRWMS M&O 1999, *Classification of the MGR Uncanistered Spent Nuclear Fuel Disposal Container System [106190]*.
- Data tracking number (DTN) LL021105312251.023, Figure 2-1 is the reference for Figure 1, page 11. The DIRS lists the correct reference as Figure 2-15 (MOL.20030107.0035, page 119).
- Pages 7, 10, and 11 of DTN LL021105312251.023 are included as a reference in Table 6-1 of Section 6.3.4. This is not identified in the DIRS.
- DTN LL000319905924.144 is listed as the source of data in Figure 14 but is not listed in DIRS as applicable to Figure 14.

Condition 4

The following error was noted during the review of AMR MDL-NBS-GS-000002, Revision 01, *Geologic Framework Model:*

- The DTN that provided the elevation of the top of the boreholes used in the development of the model (DTN MO9906GPS98410.000) was not listed in Sections 4.1, 6.0, or 9.0 of the AMR or in the DIRS report for the AMR. The elevation information is required to convert borehole depth to elevation. The DTN was included in the previous version of the AMR as a

direct input DTN. This appears to be an omission from the previous revision. The checker failed to identify the missing reference.

Condition 5

The following errors were found during the review of AMR MDL-NBS-HS-000010, Revision 0, *SZ Transport Methodology and Transport Component Integration:*

- Mislabeling of all Breakthrough Curves (i.e. Vertical Axis "Normalized Concentration," it should be "Cumulative Mass Breakthrough."
- Corrections to Table 4-2.
- Add base case parameters in values in Section 4.1.

Condition 6

The following errors were found during the review of AMR MDL-NBS-HS-000004, Revision 02, *Seepage Calibration Model and Seepage Testing Data:*

- Data tabulated in Table 14 do not reflect the raw data in DTN LB0302SCMREV02.001 (1840.8 vs. 1840.7).
- Runs 83 and 80, also reflected in Table 14, are incorrect. These run numbers should be 86 and 89, respectively.

Note: Condition 6 was corrected during the audit and was issued as CR 1079 (see Section 4.3.3.1). No further actions are necessary regarding this CR. This condition was included for the purpose of trending the checking area.

4.3.2.3 *CR 1149*

The informal document review process in not addressed by Project procedures.

Requirement

QARD, Revision 13, Section 5.2, requires that work shall be controlled in accordance with controlled implementing documents.

QARD, Revision 13, Section 2.2.10, requires that implementing documents and those documents that specify technical or quality requirements be reviewed in accordance with established criteria using pertinent background information by technically competent individuals other than the preparer, considering all aspects of the document.

Condition

The current practice of performing informal reviews during the various phases of quality-affecting activities (e.g., AMR document development, checking, and review) is not controlled

by Project procedures. This practice is widespread with varying levels of documentation. No direction concerning appropriate application and use of this practice, as applied to quality-affecting activities, has been provided. Note that this condition does not intimate that this practice is wrong, but rather that this practice is not controlled, contrary to the QARD requirement for performing work in accordance with controlled implementing documents.

4.3.2.4 *CR 1150*

Traceability and transparency problems identified in the stress corrosion cracking AMR, ANL-EMBS-MD-000005.

Requirement

AP-SIII.10Q, Models, Revision 02, Attachment 2 - Model Documentation Outline states that information presented in the model documentation shall be transparent and traceable.

Section 3.21 - Transparency is described as the attribute of producing documents that are sufficiently detailed as to purpose, method, assumptions, inputs, conclusions, references, and units such that a person technically qualified in the subject can understand the documents and ensure their adequacy without recourse to the originator.

Condition

Information presented in model documentation for AMR ANL-EBS-MD-000005*, Stress Corrosion Cracking of the Drip Shield, the Waste Package Outer Barrier, and the Stainless Steel Structural Material*, is not transparent and traceable such that a person technically qualified in the subject can understand the documents and ensure their adequacy without recourse to the originator.

Examples include the following:

Section 4.0, Inputs - Information on the basis of the bending method used to load the U-bend specimens is not provided.

Section 6.12.6, Models Evaluated - The model report does not provide information supporting the testing of weld metal and base metal to determine the effect of temperature on stress corrosion cracking with the variables using thermally-aged, cold-worked, weld metal, and base metal materials.

Section 6.2.1, Threshhold stress for stress corrosion cracking initiation - The use of the ASME code safety factor for fatigue is not appropriate for stress corrosion cracking. In addition, the document provides a statement that the uniaxial stress is conservative without explanation.

Section 6.3.6 - Models Evaluated - There is no discussion on the range of microstructural differences arising from the fabrication processes in the base metal and weld metal of Alloy-22 and whether they have been evaluated relative to their effect on the stress corrosion cracking susceptibility of Alloy-22.

Section 6.3.5 - There is no discussion on the variabilities in the weld process and whether they have been evaluated and tested relative to stress corrosion cracking. In addition, the exclusion of the experimentally obtained value for K_{1SCC} in this revision of the AMR was not explained. This value was used in the previous revision.

Figure 6 - The sufficiency of crack growth rate data to support Figure 6 is not adequately explained. Specifically, only five data points from three heats were used to predict crack growth rates over six orders of magnitude. In addition, the effect of lead concentration on crack growth rate is not presented in sufficient detail to respond to issues raised by the State of Nevada. The response to the issue requires further justification and explanation.

4.3.2.5 *CR 1152*

The basis for fault selection criteria was not documented in MDL-NBS-GS-000002, *Geologic Framework Model.*

Requirement

AP-SIII.10Q, Revision 02, Section 5.3.3, requires the responsible manager or lead to ensure that the validation of the mathematical model and its underlying conceptual model includes documentation of decisions or activities that are implemented to generate confidence in the model during model development, including selection of input parameters and/or input data, and a discussion of how the selection process builds confidence in the model.

Condition

MDL-NBS-GS-000002, Revision 01, *Geological Framework Model*, Section 6.2.2, Selection of Faults, describes the criteria for selecting the faults modeled in the AMR. The basis for selection of the criteria is not provided in the document. The AMR does not discuss how the criteria were selected nor does it provide the basis for the decisions.

4.3.2.6 *CR 1162*

Data used as technical information.

Requirement

AP-3.15Q defines the terms data (collected) and technical information as follows:

- Data (collected) - Factual information obtained from investigation activities such as sample collection, physical measurements, testing and analyses, both in the field and in the laboratory.

- Technical information - Information not meeting the definition of data that is used as direct input.

Condition

AMR MDL-NBS-HS-000010, *Site-Scale Saturated Zone Model,* contained values in Table 4-1 that met the definition of data (collected) as defined in AP-3.15Q, but were classified as technical information. This condition was previously addressed in CR 105 (BSC(O)-03-D-214), which is currently open.

4.3.2.7 *CR 1163*

DTN data qualification status listed as technical information.

Requirement

QARD Section III.2.3 B requires that data be identified in a manner that facilitates traceability to its qualification status.

Discussion

The qualification status of DTN SN0306T0502103.007 is identified in the ATDT system as Technical Information. Technical information is not a permitted qualification status under AP-3.15Q. This type of condition was previously identified during audit OQAP-BSC-03-14 and is documented in CR 789.

4.3.2.8 *CR 1164*

Software transparency problem identified with FEHM V. 2.20 validation test results.

Requirement

AP-SI.2Q, Section 5.5.1, paragraphs a) and b) state:

- Perform testing according to the Installation Test Plan (ITP) and, if required the Validation Test Plan (VTP).
- Document the results of the testing in the Validation Test Report (VTR).

Condition

Validation test results for FEHM V. 2.20 were appended as Attachment 1 of the VTP (10086-VTR-2.20-00) rather than the VTR (10086-VTR-2.20-00).

4.3.2.9 *CR 1168*

Multiple data issues identified with AMR EBS-GE-000004, *Effects of Fault Displacement on Emplacement Drifts.*

Requirements

The requirements at the time of the development of the document were:

Requirement 1

AP-3.10Q, Revision 02, *Analyses and Models*, Section 5.5.3, requires the checker to check the analysis or model documentation to ensure that inputs were:

- correctly selected;
- identified in the analysis or model documentation and on the DIRS report;
- cited and incorporated; and
- appropriate for use in the analysis or modeling activity.

Section 5.5.3 also requires that any assumed parameters or other input values be clearly identified and justified, and any appropriate to-be-verified (TBV) tracking numbers be included in the DIRS.

Requirement 2

AP-3.15Q, Revision 01, ICN 01, Section 5.2.2 and Attachment 4 require that:

- If assumptions are directly needed to continue progress on the development of the technical product in place of missing information and require further confirmation, use initial use as the reference type and document the assumption as the input description (with a TBV, if necessary) per Attachment 4.

Requirement 3:

AP-3.10Q, Revision 02, Section 5.2, requires:

- For both an analysis and a model, the originator must define the intended use of the analysis and/or model and the appropriateness of the analysis and/or model for its intended use. The appropriate level of confidence in the analysis or model shall include defining the appropriateness of all inputs used in the analysis or model for their intended purpose.

Condition

AMR ANL-EBS-GE-000004*,* Revision 00, ICN 01, *Effects of Fault Displacement on Emplacement Drifts*, with Errata 31673, did not meet procedural requirements in effect at the time the document was developed, nor does it meet current procedural requirements. The audit team identified issues related to the management of data and technical inputs. Examples include:

- Contrary to requirement 1, Section 4.0 states that no data or parameters, other than assumptions, are used in the analysis. However, the assumptions include numerical values that are used in the analysis and the criteria in section 4.0 include numerical values that are used in the analysis.

- Contrary to requirement 1, the numerical values (data) in the assumptions are not supported by reference, in-text rationale, justifications, or documentation.

- Contrary to requirement 1, numerical values used in the analysis have no DTNs and their qualification and verification status are indeterminate.

- Contrary to requirement 2, assumptions are unsupported with source reference, basis discussion, or documentation.

- Contrary to requirement 3, conceptual models of fault displacement are presented in the assumptions section. However, these models are not referenced and their development is not documented. Statements of fact and conclusions regarding these fault displacement models are unsupported in the text.

Additional technical comments:

- Assumptions regarding fault length are internally inconsistent between Sections 5.6 and 5.8.

- The objective of the analysis is poorly stated and developed, and the scientific approach and methodology is poorly developed and implemented.

4.3.2.10 ***CR 1169***

TWPs and AMRs do not clearly and consistently describe model validation requirements.

Requirements

QARD, Revision 13, Section III.2.6 B, requires that documentation of models shall be in accordance with the QARD Section 17.0, Quality Assurance Records, shall be transparent; and shall include:

- A description of the conceptual model and scientific basis, as well as alternatives for the selected conceptual model, including the rationale for not selecting alternatives.

- Identification of and rationale for assumptions that are made to develop or apply the model, including model idealizations as well as those assumptions that support the input to the model and impact model results.

QARD, Revision 13, Section III.2.6 D, requires that the intended use of the model and the importance of the model for assessing repository system performance determine the appropriate level of confidence for a model.

QARD, Revision 13, Section III.2.6 E, requires that model validation criteria address the following:

- Criteria used to establish the adequacy of the scientific basis for the model shall be consistent with the model application and justified in the model documentation.

- Criteria used to demonstrate that the model is sufficiently accurate for its intended use shall be consistent with parameter uncertainties and justified in the model documentation.

- Describe the relative level of confidence for the model.

AP-SIII.10Q, Revision 2, ICN 0, Section 5.3.1, requires that the model validation activity:

- Document the criteria used to determine that the needed level of confidence for the model has been met as described in Section 7 of the Model Documentation Outline.

- The criteria used to establish the adequacy of the scientific basis for the model must be consistent with the intended use of the model and must be justified in the documentation.

- The criteria used to demonstrate that the model is sufficiently accurate for its intended use must be consistent with parameter uncertainties and must be justified in the documentation.

- Validate the model to the level of confidence required in accordance with the TWP and Section 5.3.3c) of AP-SIII.10Q.

- Document model validation as described in Section 7 of the Model Documentation Outline.

Condition

TWPs and AMRs do not clearly and consistently describe criteria for model validation. This observation is based on a review of TWPs and the CR 99 verification team preliminary results. A review of the AMRs included in the scope of the audit determined that scientific basis, assumptions, level of confidence, accuracy, and uncertainty often lack clarity, consistency, and transparency as described in the AMRs and as required by the QARD and the modeling procedures. This lack of clarity and specificity in validation criteria and results does not seem to provide a high level of confidence in the model.

Examples include AMRs for Saturated Zone Flow and Transport (S0025 and S0045), Unsaturated Zone Flow and Transport (U0060), Waste Package Degradation (W0050 and W0095*)*, and others. This list is not comprehensive; the reader is referred to the CR 99 Verification Team report (transmitted to DOE on November 7, 2003 – MTS tracking number YMC41-006) for additional information regarding the specific AMRs that were reviewed in addition to the specific problems that were identified. The CR 99 Verification Team identified unsatisfactory conditions in the areas shown in Table 2.

Table 2. Summary of Problem Areas Identified During CR 99 Verification Activities

Criterion	AMRs Sampled	No. Unsat. AMRs
Adequacy of Scientific Basis	15	4
Accuracy for the Intended Use	15	6
Accuracy Consistency with Parameter Uncertainty	15	4
Impact of Aggegate Input Uncertainties	16	6
Level of Confidence Criteria	14	6

4.3.2.11 ***CR 1172***

Model assumptions were not identified and described in Section 5 of some AMRs.

Requirements

QARD, Revision 13, Section III.2.6 B, requires that documentation of models shall be in accordance with QARD Section 17.0, Quality Assurance Records, shall be transparent; and shall include:

- Identification of and rationale for assumptions that are made to develop or apply the model, including model idealizations as well as those assumptions that support the input to the model and impact model results.

AP-SIII.10Q, Revision 2, ICN 0, Attachment 2, Section 5, requires that Section 5 of model reports provide a list of the assumptions used to perform the model activity. Assumption discussions must include the following:

- Assumptions in immediately preceding upstream documentation or input documentation that may significantly impact the results of the present model.

- Assumptions made to develop the model and the rationale for the assumptions.

- Statement whether the assumption requires confirmation. If an assumption is determined not to require further confirmation, provide justification. Assumptions that require confirmation by testing, analysis, or design must also be designated in accordance with AP-3.15Q.

- Identify the subsections where assumptions are used. For frequently used assumptions, the comment "used throughout" may be substituted instead of individual references.

Condition

1. As confirmed with the AMR author, three assumptions were used in AMR MDL-NBS-HS-000010, *Site-Scale Saturated Zone Model*, that were not identified in Section 5, Assumptions. These assumptions were identified in Section 6 of the AMR with the implication that they were statements of fact. The Section 6 treatment of these assumptions was not consistent with AP-SIII.10Q requirements.

2. Eight assumptions identified in Revision 0 of MDL-NBS-HS-00004, *Seepage Calibration Model and Seepage Testing Data,* were not carried over into the same section as identified in Revision 02 of this AMR. The audit team re-evaluated two of the descriptions and determined that they were assumptions and should be in Section 5 of the AMR.

A management memorandum, dated February 2, 2003, was written in an attempt to clarify how assumptions should be documented and to provide guidance to make the assumptions section of model reports more consistent. The memorandum makes a distinction between an assumption

and a description of the conceptual model and indicates that assumptions go in Section 5 and a description of the conceptual model goes in Section 6 or 7. However, the memorandum has apparently led to some confusion about the definition and placement of assumptions.

4.3.2.12 ***CR 1173***

Compliance with TWP requirements were not being met by some AMRs.

Requirement

AP-SIII.10Q, Revision 2, ICN 0, specifies the following requirements for TWP compliance:

- Section 5.2.1, paragraph a), requires that the modeling activity and associated tasks shall be performed in accordance with the TWP and all applicable procedures.

- Section 5.3.1, paragraph d), requires model validation to the level of confidence required in accordance with the TWP.

- Section 5.3.2, paragraph a), requires the Chief Science Officer to review draft documentation of the validation activities to determine if the appropriate level of confidence, as identified in the applicable TWP, has been obtained.

- Section 5.4.3, paragraph a), requires the checker to check the model documentation to ensure that validation has been completed in accordance with the applicable TWP.

- Section 5.4.4, paragraph a), requires the QER to perform a QA check to ensure procedural and TWP compliance.

Condition

The audit team identified several conditions related to the content, implementation, and use of the TWPs related to specific AMRs. These conditions were categorized as follows:

1. Failure to implement TWP requirements for model validation

2. Failure to refer to the applicable TWP when performing modeling work, as required by procedure

3. Failure to address all specified TWP requirements.

Examples relating to these categories are as follows:

- At the time of the audit, the AMR MDL-MGR-GS-000002, *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada,* was being readied for AP-2.14Q review of Draft 00G. In this version of the report, the Ash Redistribution Conceptual Model had not been validated as required by the TWP. The model

report did not take exception to the requirement and stated (first sentence under Section 2) that the modeling activities documented in this model report were performed with no variances to work described in the TWP.

It should be noted that AP-SIII.10Q specifically excludes conceptual models not implemented in mathematical models from validation requirements (Section 5.3.3, paragraph a). The Ash Redistribution Conceptual Model was not implemented in a mathematical model. Nevertheless, the TWP requirement for validation of this conceptual model was clear. During the audit, management responsible for the ASHPLUME model report and the ash redistribution conceptual model indicated that, although not required by procedure, it would be prudent to perform the validation described in the TWP given that the model provided a direct input to TSPA.

- At the time of the audit, the AMR MDL-MGR-GS-000002, Draft 00F, *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada*, had undergone Chief Science Officer review of validation activities, had received checker and quality engineering reviews at least twice, and was being readied for the AP-2.14Q review (Draft 00G). When questioned regarding applicable TWP requirements, the quality engineering reviewer stated that he had not reviewed the current revision of the TWP, but relied on the results of the Chief Science Officer review of model validation activities to satisfy the QER responsibilities. The checker stated that she was not aware of Revision 3 of the TWP TWP-WIS-MD-000007, *Igneous Activity Analysis for Disruptive Events*. Therefore, she was not aware of the validation requirement for the redistribution conceptual model. As a consequence, key personnel involved in the development and checking of this model report failed to comply with the procedural requirements to develop and review the model report for compliance with the requirements of the governing TWP.

- Model report MDL-NBS-HS-000010 did not address all of the requirements of TWP-EBS-MD-000005, Revision 05. The AMR did not address the full listing of identified FEPs identified in the TWP. In addition, the AMR did not address all the Yucca Mountain Review Plan (YMRP) criteria for quantity and chemistry of water contacting waste packages and waste forms identified in the TWP. The AMR also addressed YMRP acceptance criteria that were not included in the TWP.

- The TWP for ANL-EBS-MD-000005, Revision 01, identified two methods for validating the model: 1) Corroboration with information published in refereed journals or literature, and 2) technical review. The validation method used was the corroboration of model results with data acquired from the laboratory, field experiments, analog studies, or other relevant observations, not previously used to develop or calibrate the model. There was no evidence that the technical review required by the TWP was performed.

4.3.2.13 ***CR 1177***

The same data were used to validate the model as were used in the model for the stress corrosion cracking AMR, ANL-EBS-MD-000005.

Requirement

AP-SIII.10Q, Revision 2, Section 5.3.3, requires that mathematical models be validated for their intended purpose and stated limitations, and to the level of confidence required by the relative importance of the model to the potential performance of the repository system. Validation is required for all mathematical models and their underlying conceptual models (validation is not required for conceptual models not implemented in mathematical models). When corroboration of model results with data acquired from the laboratory, field experiments, analog studies, or other relevant observations is used as the validation method, the corroboration data cannot be the same data as previously used to develop or calibrate the model.

Condition

The model used for ANL-EBS-MD-000005, Revision 01, had not been validated for Yucca Mountain conditions, nor for Alloy C-22. Specifically, the same samples used to determine the n value were the same samples used to validate the model, as stated in the model validation section of the AMR. Even though new data points were plotted as a result of additional exposure time on these samples, the samples are the identical ones that were used to calculate n. The additional exposure time extended the measured limits of the model.

In addition, discussions with the BSC Principle Investigator and management provided a better explanation of the model validation than that presented in the AMR. BSC stated that the model was previously accepted in the industry for stainless steel and certain nickel alloys, that they used this existing model to predict the n value for Alloy C-22, and that further validation by the Project was not necessary.

The audit team contention was that the industry model was not validated for Yucca Mountain conditions. Specifically, the model was used in industry only for stainless steel and Alloy 600, but not for Alloy C-22. In addition, the model was validated for reactor primary coolant water and not for the water conditions expected at Yucca Mountain. The test samples described in the AMR posit a value of n for Alloy C-22. There ware no industry data to confirm the n value for Alloy C-22. The Yucca Mountain testing was the first to determine n for Alloy C-22. The samples tested and the data gathered established an n value and confirmed a curve that was predicted based on that value for n. There were no independent tests based on independent data (i.e., different samples) performed to confirm the results from the samples tested.

The samples used for the longer-term testing in the AMR to determine n are the same samples that are used in the AMR for the validation. These data are not independent of the original data used to calculate n for Alloy C-22. The audit team contended that the characteristics of the industry testing were sufficiently different from the Yucca Mountain conditions to require a specific validation of the data gathered for Yucca Mountain.

4.3.3 Minor Conditions Adverse to Quality (Level C)

A total of five Level C condition reports were issued. These conditions, all of which were corrected during the audit, are described below.

4.3.3.1 *CR 1079*

Transcription errors were identified in the seepage calibration AMR, MDL-NBS-HS-000004.

Condition

1. Numbers on Table 14, page 106, of MDL-NBS-HS-000004, Revision 2, *Seepage Calibration Model and Seepage Testing Data*, did not reflect those contained in the raw data of DTN LB0302SCMREV02.001.

2. A reference error was uncovered in Table 14. Runs 83 and 80 were actually runs 86 and 89, respectively.

4.3.3.2 *CR 1129*

Missing verification of education and experience (VoEE) identified for one AMR developer.

Condition

No VoEE was on file for the primary user of AMR MDL-NBS-GS-000002, Revision 0, ICN 02, *Geologic Framework Model*. The only record on file was a resume in the Records Information System. The individual is no longer on the Project. This individual was included in the extent of condition to CR 99. It was determined during the impact analysis that this individual was not working on quality activities. Though this was a true statement at the time of the analysis, that individual's previous involvement with the Project did involve work on quality activities.

This condition was corrected, and the auditor verified VoEE 2057 dated November 3, 2003.

4.3.3.3 *CR 1142*

Missing checking and review records for AMRs ANL-WIS-MD-000004, Revision 02, and ANL-EBS-MD-000037, Revision 02.

Condition

Review of the AP-2.14Q review records coversheet for AMRs ANL-WIS-MD-000004, Revision 02, *DSNF and Other Waste Form Degradation Abstraction*, and ANL-EBS-MD-000037, Revision 2, *In-Package Chemistry Abstraction*, indicate "see attached criteria" as the specified review criteria. No review criteria were observed in the records packages for these AMRs.

Corrective action was completed during the audit by issuing the review criteria for the two AMRs and transmitting them to the RPC. Appropriate links to existing submittals were included.

4.3.3.4 *CR 1160*

Missing records identified related to MDL-WIS-PA-000003, *Seismic Consequence Abstraction*.

Condition

AMR MDL-WIS-PA-000003, Revision 00, *Seismic Consequence Abstraction*, Records Package, MOL.20030818.0006, was missing the following records:

1. List of reviewers and review criteria. This information was not attached to the review record.

2. E-mail response to one AP-2.14Q Review Record Comment Sheet.

3. Chief Science Officer e-mails dated April 10, 2003, and July 1, 2003, addressing the *Seismic Consequence Abstraction Model*, designated as QA records.

The auditor verified that the missing records were obtained and transmitted to the Records Processing Center and linked to the MOL.20030818.006 records package.

4.3.3.5 *CR 1178*

The Colloid-Facilitated Transport Model in AMR MDL-NBS-HS-000010 required additional validation.

Condition

1. AMR MDL-NBS-HS-000010, *Site-Scale Saturated Zone Model* (identified as a BIN 2 Model and traced using TER-02-0061) includes the *Colloid Facilitated Transport Model,* which required additional validation. The technical error report was not addressed in the AMR, as required. BSC 2003-161620, *Waste Forms and in-Drift Colloids Associated Radionuclide Concentration: Abstraction and Summary,* Document 20030626.0006, makes reference to the technical error report on the coversheet of the AMR.

2. Additional text needs to be added to Section 7.1.2.5 to distinguish between reversible and irreversible colloid-facilitated transport.

The additional text and a table were added to the AMR as part of Draft E and were verified during the audit.

4.3.4 Opportunities For Improvement (Level D)

Nine Level D CRs were issued by the audit team as improvement opportunities. These CRs are described below.

4.3.4.1 *CR 1078*

Improvements to MDL-NBS-HS-000004, *Seepage Calibration Model and Seepage Testing Data*.

Description

The current implementation of parameters from the Seepage Calibration Model in the seepage abstraction assumes that the results from the model are spatially extrapolated throughout the entire repository block, only dependent if the rock is lithophysal or non-lithophysal. This assumption could be strengthened by presenting a geological model that describes the geological controls on fracture intensity, variations, lithophysal density, etc. Authors should add a discussion of the geological controls on salient seepage model input parameters and discuss why the calibration locations are representative.

4.3.4.2 *CR 1130*

Track external software training and retain training information as a Project record.

Description

During the audit it was noted that it was not required to retain training records related to external software training courses. When used in Project activities, personnel receiving external software for use should be trained to the software and this training should be documented as part of the training record.

4.3.4.3 *CR 1140*

Improvements to MDL-MGR-MD-000001, *Biosphere Model Report*.

Description

The following opportunities for improvement were identified with respect to AMR MDL-MGR-MD-000001, Revision 00, *Biosphere Model Report.*

- The description of the f_enhance parameter does not fully reflect the justification in the source parameter input AMR. Authors should revise Section 6.4.2.1, page 6-55, first paragraph, to better reflect the justification in the soil parameter AMR, Section 6.5, Page 31 (ANL-NBS-MD-000009, Revision 01).

- The source of the evaporative cooler model is not well identified. This model was developed by the Project specifically for Amargosa Valley climate applications. Authors should revise the report to clearly identify that the evaporative cooler model has been developed by the Project to specifically address the unique modeling application in the Amargosa Valley.

- No data exist for the f_evap parameter used in the evaporative cooler model. As a consequence, the theoretical range of 0 to1 is used to encompass the full range of uncertainty. Development of data for this parameter should be considered. Results of the ongoing sensitivity analysis will guide this. Radionuclide-specific information should be considered. Currently, this theoretical range encompasses potential dose from changing evaporator pads. If the f_evap range is lowered, the potential dose from this pathway could no longer be covered. A scoping analysis could be needed to evaluate the potential for inhalation dose from changing the evaporative pad.

4.3.4.4 *CR 1141*

Over reliance on checker review process to identify corrections.

Description

While examining the checking process for one AMR (ANL-WIS-MD-000021, Revision 00), it appeared, based on a staff member remark, that many of the referencing details were deferred to the checker review process. A review of the AMR check records confirmed that there were excessive checker comments concerning reference inadequacies. Over reliance on the checker to clean up references introduces the potential that the checker will miss errors in other areas due to extensive time and effort placed on references. In addition, corrected and/or completed references may not receive a fully independent check. BSC should continue to emphasize to authors that they are responsible for a complete and accurate report before submittal for checking. Consider adding direction for checkers to reject a report when an excessive number of errors are found, instead of proceeding to correct the entire report.

4.3.4.5 *CR 1153*

Improvements to MDL-WIS-PA-000003, *Seismic Consequence Abstraction*.

Description

The following improvement opportunities were identified with respect to MDL-WIS-PA-000003 Revision 0, *Seismic Consequence Abstraction*:

- The AMR references TWP-MGR-MD-000015, Revision 03. The current TWP revision is Revision 04, ICN 01. Issue an ICN that references the appropriate TWP.

- Perform a global search of the AMR to ensure references to the YMRP (NUREG-1804) are correct.

- Revise the AMR to bring forward the idea that there is conservatism in the ground motions with annual exceedance probabilities of less than 10^{-6}, especially for the 10^{-7} hazard level or lower, to the point that these ground motions may be physically unrealizable. In addition, include a statement that studies are currently ongoing to develop realistic upper ranges in ground motions, and these could change the results in the AMR. These revisions to the document could be in the report introduction and/or conclusions.

4.3.4.6 *CR 1155*

Improvements to MDL-MFR-GS000002, *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada*.

Description

The following changes are recommended to the ASHPLUME AMR, MDL-MGR-GS-000002, retitled as *Atmospheric Dispersal and Deposition of Tephra from a Potential Volcanic Eruption at Yucca Mountain, Nevada,* to improve defensibility:

- Describe the basis for the RMEI location.
- Briefly explain the differences between V 1.4 and V 2.0 of the ASHPLUME program.
- Enhance consistency between Tables 8 and 15.
- Explain the basis for inclusion of the Ash Redistribution Model in this model report.
- Clarify what was meant by the "ash redistribution validation study" on page 62 of Rev. 00F.
- Discuss all validation activities in Section 7.
- In Section 7.1, remove reference to SPGM and Level II validation of the ASHPLUME model. Describe the Level III validation that was performed, as required by the TWP.

4.3.4.7 *CR 1157*

Treatment of KTIs in TWPs and AMRs.

Description

Treatment of KTIs is not uniform in TWPs and AMRs. Add language to AP-2.27Q, Revision 1, ICN 1, to clarify management expectations in this area. Examples of nonuniform coverage of KTIs include the following:

1. AP-2.27Q, Revision 0, ICN 0, was silent on the subject of KTIs. However, the TWP (TWP-MGR-MD-000015, Revision 4) prepared under AP-2.27Q, and corresponding to the AMR *Drift Degradation Analysis* (ANL-EBS-MD-000027, Revision 2), contains a very specific discussion and reference by number to several KTIs. The discussion in the AMR is very comprehensive and references the KTI numbers.

2. AP-2.27Q, Revision 1, ICN 0 and ICN 1, contain one-sentence statements referring to the inclusion of KTIs in the TWPs. These statements are not well articulated and lead to varying treatments in TWPs. For instance, there are four locations in TWP (TWP-WIS-MD-000007, Revision 3), corresponding to the AMR, *Dike/Drift Interactions* (MDL-MGR-GS-000005, Revision 0*)*, where KTIs are discussed without specific mention of the KTI number.

3. In contrast to item 2, the audit team could not find any mention of KTIs in TWP-WIS-MD-000008, Revision 2, ICN 01, corresponding to the AMR, *Igneous Intrusion Impacts on Waste Package and Waste Forms* (MDL-EBS-GS-000002, Revision 0).

4.3.4.8 *CR 1158*

Update the *Scientific Processes Guidelines Manual*.

Description

AP-SIII.10Q and AP-SIII.9Q refer to the *Scientific Processes Guidelines Manual* for supplemental guidance. This guidance document is not current. A cursory review revealed that the document contained wrong reference paragraphs, wrong model levels, and other errors. Use

of the existing manual could result in the wrong information being used leading to a potential condition adverse to quality. The audit team recommends that an update be issued to this document and maintained under document control or, alternatively, that the document be deleted and the reference removed from AP-SIII.10Q and AP-SIII.9Q.

4.3.4.9 *CR 1159*

Incorporation of microsphere breakthrough data in MDL-NBS-HS-000010, *Site-Scale Saturated Zone Model.*

Description

Incorporate microsphere breakthrough data from C-wells testing. Use of these data in the S*ite-Scale Saturated Zone Model* will support the particle transport aspect of model validation.

4.3.5 Discussion Of Previously Identified Conditions Related To Analysis Model Reports

The audit team evaluated closed CRs initiated in fiscal year 2003, to determine if previously identified closed conditions in the area of AMRs continue to remain resolved. Open CRs were not specifically evaluated during this audit for repetitiveness because corrective actions were still in process; however, where repetitive conditions were identified during the audit that were related to an open CR, these were identified in Section 4.2. In addition, the audit team examined the impact of conditions identified during this audit on the effectiveness of the CR 99 corrective actions.

4.3.5.1 *Impact of Identified Conditions on CR 99 (CAR BSC-01-C-001) Corrective Actions*

The corrective action plan for CR 99 specified significant changes to the processes governing AMR development and validation. Key corrective actions included the following:

- Chief Science Office review of TWPs and AMRs (to include formal evaluation of model validation plans)
- Clarification of model validation responsibilities in AP-SIII.10Q
- Model validation plan descriptions in TWPs
- Modeling process training
- Work scheduling to provide for checking, preparation, and review
- Self-identification of problems with AMRs
- Establishment of a technical error reporting process

The CR 99 corrective action plan has been implemented, and CR 99 is currently being verified. Several of the CRs have a bearing on the effectiveness of those corrective actions. A discussion of those conditions in light of CR 99 corrective action follows.

- CR 1173 – This condition noted noncompliances with TWPs, including noncompliance with validation requirements specified in TWPs. The CR 99 corrective action included formal review of TWPs and in process AMRs to self-identify problems. Implementation of corrective action was ineffective in this instance.

- CR 1138 – This condition noted multiple instances of errors in AMRs. The CR 99 corrective action included provisions to self-identify problems before issuing AMRs and included a commitment to perform work scheduling to allow sufficient time for AMR checking and review. The instances of errors in AMRs identified during the audit provide evidence that these actions might not have been fully implemented.

- CR 1150 – This condition noted traceability and transparency problems in one AMR. The audit team determined that effective implementation of the added review provisions introduced through CR 99 corrective action should have prevented this type of condition.

- CR 1172 – This condition report noted improper documentation of assumptions (a condition that was disputed by BSC management). CR 99 corrective action included training on the modeling process, which included identification of assumptions. During the audit, it became apparent that model developers and responsible management had varying and often differing views regarding what constitutes assumptions. These apparent differences provide an indication that the training might not have been effective in this area. However, the audit team concluded that the training coverage of the overall modeling process was extensive and adequate.

- CR 1169 – This condition identified a lack of clarity and specificity in AMRs and TWPs in relation to validation criteria. This conclusion was based on review of 20 AMRs during the audit and the CR 99 verification exercise, which showed that 25 percent of these AMRs were unsatisfactory in this area. This condition is an indication that corrective action implementation was ineffective in this area.

- CR 1178 – This condition, which was closed during the audit, identified an incompletely validated model. This condition is an indication that corrective action related to model validation was incompletely or ineffectively implemented.

The extent and scope of specific CR 99 corrective actions appear to be adequate and appropriate. However, the CRs noted above lead to a conclusion of incomplete implementation of those corrective actions. The audit team concluded, however, that significant improvements in modeling and model validation have been achieved. The AMR validation failure rate improved from 87 percent at the time CR 99 was initiated to the 25-percent rate noted during CR 99 verification. This improvement notwithstanding, complete implementation of CR 99 corrective action has not been achieved to date.

4.3.5.2 *Previously Identified Conditions for Analysis Model Reports With No Noted Recurrences of the Deficient Condition*

The following previously identified condition reports were evaluated during the audit, and there were no noted recurrences of the deficient condition:

- BSC(B)-03-O-007 - Review copies of an analysis report were not signed by the required personnel.
- BSC(B)-03-O-011 - Incorrect draft of TWP-NBS-GS-000003 for the integrated site model sent to document control.
- BSC(B)-03-D-030 - Lack of U.S. Geological Survey (USGS) approval signatures on TWP that impact the USGS.
- LLNL(B)-03-O-021 - Incorrect designation of submitted data.
- BSC(B)-03-D-037 - No objective evidence of two Technical Data Information Forms being submitted to the RPC.
- BSC(B)-03-D-045 – Inaccurate data description entries into the ATDT.
- BSC(B)-03-D-047 - Performance of activities not called out in the governing TWP.
- BSC(B)-03-D-051 - Failure to identify DTNs for data listed in an approved technical report.
- BSC(B)-03-D-054 - Failure to generate record road map for data sets.
- BSC(B)-03-O-069 - TWP approved before resolution of mandatory comments.
- BSC(B)-03-D-076 - TWP not transitioned from AP-2.21Q to AP-2.27Q within 6 months of the effective date.
- BSC(B)-03-O-076 - Work package numbers not on cover sheet of TWP.
- BSC(B)-03-O-079 - Quality-affecting activities performed without TWP in place.
- BSC(B)-03-O-080 - A post-Process Validation and Reengineering data set (DTN) includes a Quality Verification Level-2 DTN within it.
- BSC(B)-03-D-084 - Incorrect direct inputs into model report.
- BSC(B)-03-D-091 - Data errors in Los Alamos National Laboratory scientific notebooks.
- BSC(O)-03-D-129 - Non-specific data evaluation criteria.
- BSC(O)-03-D-130 - Failure to apply data evaluation criteria during data qualification.
- BSC(O)-03-D-134 - Data submittal records packages do not include all required information.
- BSC(B)-03-D-136 - Incorrect DTN data entry.
- BSC(B)-03-D-143 - Model report not approved by the Responsible Manager.
- BSC(B)-03-D-150 - TWP not developed as required.
- BSC(B)-03-D-152 - Record road maps not developed and record packages not sent to the RPC for the geographic information system data packages.
- BSC(B)-03-D-206 - TWP approved before to resolution of mandatory comments.
- BSC(B)-02-O-078 - DTN reference in AMR.
- BSC(O)-02-D-123 - No records road map developed for data submitted to the TDMS.

- USGS(B)-02-D-126 - Data records packages did not include the reviewed data as required by AP-2.14Q.
- BSC(B)-02-D-144 - Parameters represented by Table 4-1 of the analysis of infiltration uncertainty are not adequately justified.
- BSC(B)-02-D-191 - Use of unqualified data from uncontrolled source.

4.3.5.3 *Previously Identified Conditions for Analysis Model Reports With Recurrences of the Deficient Condition*

This section lists the CRs that this audit identified that are repetitive of previous conditions.

1. CR 1162 identified a condition that was a repeat of:

   - BSC(O)-03-D-014, Direct Input of Unqualified Data Into Models and Analyses as Assumptions.

   - CR 79 [BSC(O)-03-D-214], Unqualified Data introduced as Technical Information.

2. CR 1129 identified an isolated condition related to VoEE that was addressed previously by:

   - CR 78 [BSC(O)-02-D-176]
   - CR 105 [CAR BSC-02-C-001]

It was determined that the extent of condition investigation performed for CR 105 inadequately evaluated the specific individual identified in CR 1129. This condition was isolated and corrected during the audit.

3. CRs 1138, 1132, 1150, 1168, 1172, and 1173 address traceability and transparency issues. These CRs are similar to BSC(O)-03-D-135 - Lack of traceability and transparency in AMRs.

4. CRs 1142 and 1162 address records submittal issues. These CRs are similar to the following past conditions:

   - BSC(B)-03-D-017 - Late submittal of required records.
   - BSC(O)-02-D-172 - No objective evidence of review records for TWP-MGR-MD-000010, Revision 1 being submitted to RPC.

5.0 LIST OF ATTACHMENTS

Attachment 1 – Personnel Contacted During the Audit
Attachment 2 – Summary Table of Audit Results
Attachment 3 – Documentation Evaluated During the Audit

Attachment 1 – Personnel Contacted During the Audit

Name	Organization	Pre-Audit Meeting	Contacted During Audit	Post-Audit Meeting
Aden-Gleason, Nancy	LBNL/EA	✓	✓	✓
Ambos, Dale	BSC		✓	
Andrews, Robert	BSC/PA		✓	✓
Atkisson, Al	BSC/B&A		✓	
Beall, Ken	BSC/CM			✓
Becker, Naomi	LANL		✓	
Bennington, Mary E.	DOE/OQA	✓		
Bernot, Patricia	BSC/EBS		✓	
Biggar, Norma	BSC/Natural Sys.		✓	✓
Blaylock, James	DOE/OQA			✓
Boyle, William	DOE/ORD	✓		✓
Brown, R. Dennis	DOE/OQA	✓		✓
Brient, Robert (Observer)	CNWRA	✓		✓
Capshaw, Roy	DOE-HQ/RW/OQA	✓		✓
Cereghino, Stephen	BSC/LA	✓		
Chipman, Veraun	BSC/PA		✓	
Clark, John J.	BSC			✓
Cline, Michael	BSC/IA/DE	✓	✓	
Clower, Curtis	BSC		✓	✓
Codell, Richard (Observer)	NRC	✓		✓
Cross, Jin	BSC Consultant	✓		
Dana, Steve	BSC/QE			✓
Derby, Shirl	BSC			✓
Dixon, Paul R.	LANL	✓	✓	✓
Domski, Paul	BSC/ FRAMATOME		✓	
Dove, Floyd H. (Technical Specialist)	OQA/NQS	✓		✓

Attachment 1 – Personnel Contacted During the Audit - Continued

Name	Organization	Pre-Audit Meeting	Contacted During Audit	Post-Audit Meeting
Doyle, John R. (Auditor)	OQA/NQS	✓		✓
Dyer, Russ	DOE/ORD	✓		✓
Evilsizer, John	BSC/ATSS			✓
Finsterle, Stefan	LBNL	✓	✓	✓
Fissekidou, ViVi	LBNL		✓	
Foster, Bruce (Audit Team Leader)	OQA/NQS	✓		✓
Ghezzehei, Teamrat	LBNL		✓	
Gilkerson, Ken	BSC/QE		✓	
Glasser, Bill	OQA/NQS		✓	
Gomes, Jeanette	BSC/HR		✓	
Gordon, Gerald	FANP/WPM&M		✓	
Grooms, Kerry	DOE/ OQA	✓		
Gross, Mike	California B&A		✓	
Habbe, Robert	BSC/QA			✓
Hardin, Ernest L.	BSC/ Nat. Syst.		✓	
Harper, James B. (Auditor)	BSC/QA	✓		✓
Harris, Donald J. (Auditor)	OQA/NQS	✓		✓
Harris, Steve	LBNL		✓	✓
Hartstern, Robert	BSC/QA			✓
Hasson, Robert	NQS	✓		✓
Hill, Brittain (Observer)	CNWRA	✓		
Horseman, Marlin (Auditor)	OQA/NQS	✓		✓
Houseworth, James	BSC/UZ	✓	✓	✓
Humphries, Cindy	BSC/QA		✓	
Hunemuller, Neal K.	DOE/ORD			✓
Abou-Bakr Ibrahim (Observer)	NRC	✓		
Ikenberry, Tracy (Technical Specialist)	Dade Moeller & Associated	✓		

Attachment 1 – Personnel Contacted During the Audit - Continued

Name	Organization	Pre-Audit Meeting	Contacted During Audit	Post-Audit Meeting
Jaeger, Michael	BSC/PA	✓	✓	✓
Kavchak, Marilyn	NQS	✓		✓
Keating, Gordon	LANL		✓	
Keele, Robert P.	BSC/QA			✓
Kelkar, Sharad	LANL	✓	✓	
King, Jerry L.	BSC/DE	✓	✓	
Kuzio, Stephanie	SNL		✓	
La Pointe, Paul (Technical Specialist)	Golder	✓		✓
Latta, Robert	NRC/OR	✓		✓
Leem, Junghum	BSC/EBS		✓	
LeStrange, Susan	BSC/EBS		✓	
Liu, H. H.	LBNL		✓	
Lu, Stephen	LLNL		✓	
Lum, Clinton	SNL		✓	
Marks, Steve (Technical Specialist)	Golder	✓		✓
Martinez, Cleoves B.	LANL/EA	✓		
Mason, Jeff	BSC/SCM		✓	✓
Mason, Michael	BSC/QA			✓
Matula, Tom	NRC	✓		✓
McFall, Ken	BSC/QE		✓	
Mitchell, John	BSC/GM			✓
Nitti, Don	BSC/ACD		✓	
Nutt, Mark	MTS	✓	✓	✓
Orrell, Andrew	SNL		✓	
Pan, Yi-Ming (Observer)	CNWRA	✓		✓
Pasupathi, Venkataraman	BSC/WPM&M	✓	✓	✓

Attachment 1 – Personnel Contacted During the Audit - Continued

Name	Organization	Pre-Audit Meeting	Contacted During Audit	Post-Audit Meeting
Persoff, Peter	LBNL		✓	
Peters, John	BSC		✓	✓
Prince, J. R.	BSC/Licensing	✓		
Quittmeyer, Richard	BSC/DE		✓	
Rasmuson, Kaylie	BSC			✓
Rautenstrauch, Kurt	BSC/ES&H	✓	✓	
Reimus, Paul	LANL		✓	
Rodgers, Thomas	BSC/Engineering	✓	✓	
Savino, John M. (Technical Specialist)	MTS	✓		✓
Schreiner, Randy	BSC/ES		✓	
Schuermann, Steve	BSC			✓
Serougian, Dave	BSC/PA		✓	
Shipman, Judy (Auditor)	BSC QA	✓		✓
Siegmann, Eric	FRAMATOME		✓	✓
Simmons, Ardyth	LANL			✓
Smith, A. J.	BSC/Framatome		✓	✓
Sorensen, C. D.	BSC			✓
Spangler, Elaine	BSC/Training		✓	
Splawn, Steve	BSC/SCM		✓	
Stahl, David	BSC/CSO		✓	
Statham, William	FRAMATOME		✓	
Stein, Arthur (Technical Specialist)	Stone & Webster	✓		✓
Summers, Tammy	LLNL		✓	
Svalstad, Darrell	BSC/QE		✓	
Thomas, Dan	BSC/EBS		✓	
Thomas, Dennis	BSC/Projects	✓		
Thomas, Emma	BSC/EBS		✓	

Attachment 1 – Personnel Contacted During the Audit - Continued

Name	Organization	Pre-Audit Meeting	Contacted During Audit	Post-Audit Meeting
Thompson, Kathleen	BSC/Records		✓	
Thornton, Thomas	BSC/EBS		✓	
Trbovich, Tom (Observer)	CNWRA	✓		✓
Tsang, C. F.	LBNL		✓	
Tsang, Yvonne	LBNL		✓	
Turchi, Patrice	LLNL		✓	✓
Ulshafer, Mike	DOE/OQA			✓
Viswanathan, Hari	LANL		✓	
Vogt, Tim	BSC/Nat. Syst.		✓	
Voigt, James V. (Auditor)	OQA/NQS	✓		✓
Walter, Gary (Observer)	CNWRA	✓		
Wang, Joe	LBNL		✓	
Warren, Charlie	LLNL		✓	✓
Wasiolek, Maryla	BSC/Bio	✓	✓	✓
Weber, Carl	DOE/OQA	✓		✓
Webster, Stuart	BSC/Licensing	✓		✓
West, Donald O. (Technical Specialist)	Golder	✓		✓
Whitcraft, James	BSC/Engineering		✓	
Williams, Nancy	BSC/PM	✓		
Wisenberg, Mike	BSC/Project Eng.	✓		
Wong, Frank	LLNL		✓	
Wu, Wesley	BSC/TSPA	✓	✓	✓
Younker, Jean	BSC/CSO	✓	✓	✓
Ziegler, Joseph	DOE/OLAS	✓		✓
Zinkevich, Fred	BSC/CM	✓		

Attachment 2 - Summary Table of Audit Results

Number	Product/Area	B CRs	C CRs	D CRs	Adequacy	Implementation	Effectiveness
1	Planning and Development			1157	Satisfactory - Green	Satisfactory - Green	Satisfactory - Green
2	Documentation and Traceability	1150 1152 1172	1142 1160	1078 1140 1153 1155	Satisfactory - Green	Unsatisfactory - Red	Satisfactory - Yellow
3	Use of Data	1162 1163 1168			Satisfactory - Green	Satisfactory - Yellow	Satisfactory - Green
4	Use of Software	1132 1164	1129	1130	Satisfactory - Green	Satisfactory - Green	Satisfactory - Green
5	Model Validation	1169 1177	1178	1159	Satisfactory - Green	Unsatisfactory - Red	Satisfactory - Yellow
6	Checking and Review	1138 1173	1142	1141	Satisfactory - Green	Unsatisfactory - Red	Satisfactory - Yellow
7	Procedure Adequacy	1149		1158	Satisfactory - Green	NA	NA
8	MDL-MGR-MD-000001 *Biosphere Model Report*			1140	NA	Satisfactory - Green	Satisfactory - Green
9	MDL-NBS-HS-000010 *Site-Scale Saturated Zone Model*	1138 1162 1163 1164 1172	1178	1159	NA	Satisfactory - yellow	Satisfactory - Green
10	MDL-NBS-HS-000004 *Seepage Calibration Model and Testing Data*	1138 1172	1079	1078	NA	Satisfactory - Green	Satisfactory - Green
11	MDL-MGR-GS-000002 *Atmospheric Dispersal and Deposition*	1138 1173		1155	NA	Satisfactory - Yellow	Satisfactory - Green
12	ANL-EBS-MD-000005 Stress Corrosion Cracking of Drip Shield, WP Outer Barrier and SS Structural Material	1138 1150 1173 1177			NA	Unsatisfactory - Red	Unsatisfactory - Red
13	MDL-WIS-PA-000003 *Seismic Consequence Abstraction*		1160	1153	NA	Satisfactory - Green	Satisfactory - Blue

Attachment 3 – Documentation Evaluated During the Audit

Planning and Development

AP-2.1Q, Revision 2, ICN 2, *Personnel Training and Qualification*

AP-2.2Q, Revision 1, ICN 2, *Establishment and Verification of Education and Experience*

AP-2.14Q, Revision 2, ICN 2, *Review of Technical Products and Data*

AP-2.27Q, Revision 1, ICN 1, *Planning for Science Activities*

AP-SIII.9Q, Revision 1, ICN 0, *Scientific Analysis*

AP-SIII.10Q, Revision 1, ICN 2, *Models*

TWP-NBS-HS-000003, *Performance Assessment Unsaturated Zone*

TWP-MGR-MD-000015, Revision 03, *EBS Department Modeling and Testing FY 03*

TWP-MGR-MD-000015, Revision 4, ICN 01, *Technical Work Plan for EBS Department Modeling and Testing FY 03*

MDL-NBS-HS-000002, Revision 2, *Seepage Model for PA Including Drift Collapse*

MDL-NBS-HS-000019, Revision 0, *Abstraction of Drift Seepage*

MDL-WIS-PA-000003, Revision 0, *Seismic Consequence Abstraction*

MDL-WIS-PA-000003, *Seismic Consequence Abstraction,* Revision 0 drafts A, B, C, D, and G

MDL-WIS-PA-000003 review records and review record responses

TWP-WIS-MD-000008, Revision 2, *Technical Work Plan for Waste Form Degrading Modeling, Testing, and Analyses in Support of SR and LA*

TWP-WIS-MD-000008, Revision 2, ICN 01, *Technical Work Plan for Waste Form Degrading Modeling, Testing, and Analyses in Support of SR and LA*

TWP-WIS-MD-000007, Revision 3, *Technical Work Plan - Igneous Activity Analysis for Disruptive Events*

ANL-WIS-MD-000021, Revision 0, *Clad Degradation - Summary and Abstraction for LA*

ANL-EBS-MD-000027, Revision 2, *Drift Degradation Analysis*

MDL-EBS-GS-000002, Revision 2, *Igneous Intrusion Impacts on Waste Packages and Waste Forms*

MDL-MGR-GS-000005, Revision 0, *Dike/Drift Interactions*

Training records for checker training (LPTEC00-008)

Records of verification of education and experience for checkers

Documentation and Traceability

ANL-EBS-MD-000030, Revision 3, ICN 1, *Ventilation Model and Analysis Report*

MDL-NBS-HS-000002, Revision 2, *Seepage Model for PA Including Drift Collapse*

MDL-NBS-GS-000006, Revision 0, *Thermal Conductivity of Non-Repository Lithostratigraphic Layers*

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Attachment 3 - Documentation Evaluated During the Audit - Continued

MDL-MGR-MD-000001, Revision 0, *Biosphere Model Report*

MDL-NBS-HS-000010, Draft 0C, *Site Scale Saturated Zone Model*

MDL-NBS-HS-000004, Revision 2, *Seepage Calibration Model and Testing Data*

MDL-MGR-GS-000002, Drafts 0F and 0G, *Atmospheric Dispersal and Deposition*

ANL-EBS-MD-000005, Revision 1, *Stress Corrosion Cracking of the Drip Shield, the Outer Waste Package, and the Stainless Steel Structural Material*

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Document Input Reference Sheet, Effects of Fault Displacement on Emplacement Drifts, ANL-EBS-GE-000004 Rev. 00, ICN 01 (as of 27-Oct-2003 16:21:46)

MDL-NBS-GS-000002, Revision 01, Geologic Framework Model (GFM2000)

Model Cover Sheet for Geologic Framework Model (GFM2000), MDL-NBS-GS-000002, Revision 01, MOL.20020530.0078

Document Input Reference Sheet, Geologic Framework Model (GFM2000), MDL-NBS-GS-000002, Revision 01 (as of 27-Oct-2003 9:53)

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Attachment 3 - Documentation Evaluated During the Audit - Continued

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GS960908314224.020. Analysis Report: Geology of the North Ramp - Stations 4+00 to 28+00 and Data: Detailed Line Survey and Full-Periphery Geotechnical Map - Alcoves 3 (UPCA) and 4 (LPCA), and Comparative Geologic Cross Section - Stations 0+60 to 28+00. DIRS 106059

GS980608314221.002. Revised Bedrock Geologic Map of the Yucca Mountain Area, Nye County, Nevada. DIRS 107024

MO0002GSC00068.000. UE-25 NRG-1 Drill Hole Resurvey for Comparison. DIRS 152562

MO0004QGFMPICK.000. Lithostratigraphic Contacts from MO9811MWDGFM03.000 to be Qualified Under the Data Qualification Plan, TDP-NBS-GS-000001. DIRS 152554

MO9906GPS98410.000. Yucca Mountain Project (YMP) Borehole Locations. DIRS 109059

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ANL-EBS-MD-000006, Revision 01, *Hydrogen Induced Cracking of Drip Shield*

LL990610605924.079. LTCTF Data for C-22, TIGR7, TIGR12 and TIGR16. DIRS 104994

MO0003SPASUP02.003. Supporting Media for Calculation of General Corrosion Rate of Drip Shield and Waste Package Outer Barrier to Support WAPDEG Analysis. DIRS 147299

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MO0304SPAGLCDS.000. ANL-EBS-MD-000004, Revision 01, AMR Output. General and localized corrosion models for titanium degradation.

MO0306SPAGLCDS.001. General and Localized Corrosion Models for Titanium Degradation. ANL-EBS-MD-000004, Revision 01, Output.

LL030205912251.016, Titanium (TI) Grade 16 Corrosion Rate Data in Simulated Diluted and Concentrated Well Water (SDW AND SCW), Dimensions, Initial and Final Weights, Surface Area, and Corrosion Rate Data for TI-Grade 16 Coupons Over an Approximate Five Year Period.

LL000201305924.120. General Corrosion and Localized Corrosion of the Drip Shield. DIRS 145380

LL000209305924.129. General Corrosion and Localized Corrosion of the Drip Shield. DIRS 147729

LL000320405924.146. Target Compositions of Aqueous Solutions Used for Corrosion Testing. DIRS 148327

LL010105512251.011. General Corrosion and Localized Corrosion of the Drip Shield. DIRS 155623

LL030205912251.016. Titanium (Ti) Grade 16 Corrosion Rate Data in Simulated Diluted and Concentrated Well Water (SDW and SCW). DIRS 161755

LL030409412251.050. Electrochemical Data of Titanium Gr. 7 in CaCl2 Solutions. DIRS 163647

LL990610605924.079. LTCTF Data for C-22, TIGR7, TIGR12 and TIGR16. DIRS 104994

MO0003RIB00073.000. Physical and Chemical Characteristics of TI Grades 7 and 16. DIRS 152926

Attachment 3 - Documentation Evaluated During the Audit - Continued

MO0003SPAPCC03.004. Supporting Media for Abstraction of Models for Pitting and Crevice Corrosion of Drip Shield and Waste Package Outer Barrier. DIRS 148992

Use of Software

ANL-EBS-MD-000002, Revision 1, ICN 0, *Aging and Phase Stability of Waste Package Outer Barrier*

ANL-EBS-MD-000030, Revision 03, ICN 01 *Ventilation Model and Analysis Report*

MDL-NBS-GS-000002, Revision 01, *Geologic Framework Model*

ANL-NBS-HS-000031, Revision 01, *Saturated Zone Colloid Model*

MDL-EBS-GS-000002, Revision 00, *Igneous Intrusion Impacts on Waste Packages and Waste Forms*

EQ6 V 7.2bLV User's Manual

EARTHVISION V5.1 Installation Test Plan, Revision 00

Record Packages for the following Software were reviewed during the audit:

EQ6 7.2bLV, RELAP V2.0, EARTHVISION 5.1, ANSYS Ver. 5.6.2 , DICTRA V. M and ThermoCalc V 2.0

Model Validation

MDL-MGR-MD-000001, Revision 0, *Biosphere Model Report*

MDL-NBS-HS-000010, Draft 0C, *Site Scale Saturated Zone Model*

MDL-NBS-HS-000004, Revision 2, *Seepage Calibration Model and Seepage Testing Data*

MDL-MGR-GS-000002, Drafts 0F and 0G, *Atmospheric Dispersal and Deposition*

ANL-EBS-MD-000005, Revision 1, *Stress Corrosion Cracking of the Drip Shield, the Outer Waste Package, and the Stainless Steel Structural Material*

ANL-MGR-MD-000006, Revision 1, *Agricultural and Environmental Input Parameters for the Biosphere Model*

MDL-WIS-PA-000003, Revision 0, *Seismic Consequence Abstraction*

Scientific Processes Guidelines Manual, Revision 0

TWP-NBS-MD-000004, Revision 1, *Biosphere Modeling and Expert Support*

TWP-NBS-MD-000002, Revision 1, *Saturated Zone Flow and Transport Modeling Work Packages*

TWP-NBS-HS-000003, Revision 2, *Technical Work Plan for: Performance Assessment Unsaturated Zone*

TWP-WIS-MD-000007, Revision 7, *Technical Work Plan - Igneous Activity Analysis for Disruptive Events*

TWP-EBS-MD-000005, Revision 5, *Technical Work Plan for: Waste Package Materials Data Analyses and Modeling*

TWP-WIS-MD-000008, Revision 2, ICN 1, *Technical Work Plan for: Waste Form Degradation Modeling, Testing, and Analyses in Support of SR and LA*

Attachment 3 - Documentation Evaluated During the Audit - Continued

TWP-MGR-MD-000015, Revision 4, ICN 1, *Technical Work Plan for: Engineered Barrier System Department Modeling and Testing FY03 Work Activities*

TWP-MGR-MD-000015, Revision 4, *Technical Work Plan for: Engineered Barrier System Department Modeling and Testing FY03 Work Activities*

Checking and Review

MDL-MGR-MD-000001, Revision 00, *Biosphere Model Report*

MOY-030724-01-01 Records Review Package – Checker and AP-2.14Q Reviews

DTN MO0306MWDBGSMF.001, 6/13/03, DTN consists of 2 files: ERMYN_GW.gsm and ERMYN_VA.gsm

ANL-NBS-MD-000009, Revision 01, *Soil-Related Input Parameters For The Biosphere Model*

MOY-030923-42-01 Records Review Package – Checker and AP-2.14Q Reviews

ANL-NBS-GS-000013, Revision 00, Review Package in process in Records Center – Checker and AP-2.14Q Reviews

ANL-EBS-MD-000002, Revision 01, *Aging And Phase Stability Of Waste Package Outer Barrier*

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MOY-030930-16-01 Records Review Package

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DTN LL030406012251.019, *Modeling of NI-CR-MO Based Alloys*

MOL.20031016.0252, Review Copy Draft 01F of ANL-EBS-MD-000002

ANL-EBS-MD-000037, Revision 02, *In-Package Chemistry Abstraction*

Review Package in process in Records Center for ANL-EBS-MD-000037, Revision 02 – Checker and AP-2.14Q Reviews

DIRS for ANL-EBS-MD-000037, Revision 02

ANL-WIS-MD-000021, Revision 00, *Clad Degradation - Summary And Abstraction For LA*

MOY-030723-02-01, Records Review Package for ANL-WIS-MD-000021, Revision 00– Checker and AP-2.14Q Reviews

ANL-WIS-MD-000004, Revision 02, *DSNF and other Waste Form Degradation Abstraction*

MOY-030929-46-01, Records Review Package for ANL-WIS-MD-000004, Revision 02– Checker and AP-2.14Q Reviews

ANL-WIS-MD-000010, Revision 02, *Dissolved Concentration Limits Of Radioactive Elements*

MOY-030929-40-01, Records Review Package for ANL-WIS-MD-000010, Revision 02 – Checker and AP-2.14Q Reviews

MDL-NBS-HS-000014, Revision 00, *Analysis Of Hydrologic Properties Data*

MOY-030113-15-01, Records Review Package for MDL-NBS-HS-000014, Revision 00 – Checker and AP-2.14Q Reviews

Attachment 3 - Documentation Evaluated During the Audit - Continued

DTN MO0302SPATHDYN.000

DTN MO0302SPATHDYN.001

TrainServe Database Reviews for checker, technical work, AP-SIII.9Q, and AP-SIII.10Q for the following employee numbers: 6985, 17627, 11204, 6686, 5558, 14773, 12510

Procedure Adequacy

AP-2.1Q, Revision 2, ICN 2, *Personnel Training and Qualification*

AP-2.2Q, Revision 1, ICN 2, *Establishment and Verification of Education and Experience*

AP-2.14Q, Revision 2, ICN 2, *Review of Technical Products and Data*

AP-2.27Q, Revision 1, ICN 1, *Planning for Science Activities*

AP-SIII.9Q, Revision 1, ICN 0, *Scientific Analysis*

AP-SIII.10Q, Revision 1, ICN 2, *Models*

RTN Matrices for APs 2.14Q, 2.27Q, SIII.9Q, and SIII.10Q

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Rautenstrauch, K.R., A.J. Smith, and R. Andrews. September 2003. *Technical Basis Document No. 12: Biosphere Transport*, Revision 1.

ANL-MGR-MD-000007, Revision 01, *Environmental Transport Input Parameters for the Biosphere Model*

ANL-NBS-MD-000009, Revision 01, *Soil-Related Input Parameters for the Biosphere Model*

ANL-MGR-MD-000009, Revision 02, *Nominal Performance Biosphere Dose Conversion Factor Analysis*

MDL-NBS-HS-000010, Revision 01D, *Site-Scale Saturated Zone Transport*

ANL-MGR-MD-000009, Revision 02, *Nominal performance Biosphere Dose Conversion Factor Analysis*

MDL-MGR-MD-000001, Revision 0, *Biosphere Model Report*

ANL-NBS-HS-000031, Draft 01D, *Saturated Zone Colloid Transport*

MDL-NBS-HS-000011, Draft 01F, *Calibration of the Site-Scale SZ Flow Model*

MDL-NBS-HS-000021, Revision 0 concurrence and final review copy, *Input and Results Base Case Saturated Zone Flow and Transport Model TSPA*

MDL-NBS-HS-000008, Draft 01D, *Radionuclide Transport Models under Ambient Conditions*

MDL-NBS-HS-000004, Revision 02, *Seepage Calibration Model and Seepage Testing Data*

MDL-NBS-HS-000019, Revision 0, *Abstraction of Drift Seepage*

ANL-MGR-GS-000002, Draft 01Cpbi, *Characterize Eruptive Processes*

MDL-MGR-GS-000002, Drafts 01D, 01F, and 01G, *Atmospheric Dispersal and Deposition*

Attachment 3 - Documentation Evaluated During the Audit - Continued

ANL-EBS-PA-000001, Draft 01C, *Waste Package Degradation (WAPDEG) Analysis of Waste Package and Drip Shield Degradation*

ANL-EBS-MD-000005, Revision 01, ICN 0, *Stress Corrosion Cracking of the Drip Shield, the Waste Package Outer Barrier, and the Stainless Steel Structural Material*

MDL-EBS-GS-000002, Revision 0, *WF Igneous Intrusion*

ANL-WIS-MD-000010, Revision 02, *Dissolved Concentrations of Radioactive Elements*

ANL-WIS-MD-000021, Revision 0, *Cladding Summary Abstraction*

ANL-EBS-MD-000030, Revision 3, ICN 1, *Ventilation Model*

ANL-EBS-MD-000027, Revision 02, *Drift Degradation Analysis*

ANL-WIS-PA-000001, Draft 01F, *EBS Radionuclide Transport Abstraction*

MDL-WIS-PA-000003, Revision 0, *Seismic Consequence Abstraction*

MDL-NBS-HS-000004, Revision 0, *Seepage Calibration Model and Testing Data*

MDL-HS-000014, Rev. 00, *Analysis of Hydrologic Properties Data*

Scientific Notebook SN-LBNL-SCI-175-V1 *Niche Excavation; Liquid Flow Testing; Borehole Drilling and Pneumatic Testing; Drift Seepage Testing*, MOL. 20020725.0450

Scientific Notebook SN-LBNL-SCI-171 V1 *UZ Drift Scale Model*

Scientific Notebook SN-YMP-LBNL-SAF-Z, *Recalibration of Drift Scale Modeling Parameters Using Seepage Calibration Model*

Technical Data Information Form (TDIF) 313525, *Enhanced Characterization of the Repository Block (ECRB) Niche 5 Borehole As-Built Information*

TWP-NBS - HS-0000003, Revision 02, *Technical Work Plan for Performance Assessment of the Unsaturated Zone*

SITP-02-UZ-002, Revision 00, *Test Plan for Niche 5 Seepage Testing*

DTN LB0302SCMREV02, *Seepage-Related Parameters K and 1/A Data Summary,* TDIF-314172

DTN LA030PR831231.003, *Model Interpretations of C-Wells Field Tracer Transport Experiments*

ANL-EBS-MD-000005 , Revision 01, *Stress Corrosion Cracking of the Drip Shield, the Waste Package, and the Stainless Steel Structural Material*

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